Design of a low-cost simulator for the evaluation of surgical skills during laparoscopic radical prostatectomy

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Abstract

Objective The procedural techniques introduced by the advancement of Minimally Invasive Surgery (MIS) challenge surgeons' psychomotor skills, therefore great emphasis is put on education outside the operating room. Our project aimed to create and evaluate a phantom-based environment to assess surgical skills during laparoscopic radical prostatectomy.

Methods We developed a specially designed multifunctional trainer box to imitate the circumstances of laparoscopic surgery (Fig.1). We also designed an artificial pelvic phantom including the essential anatomical structures to represent the operational field of laparoscopic prostatectomy (Fig.2). We defined surgical tasks in accordance with the main steps of the procedure (transecting the dorsal venous plexus of the prostate, the urethra at the basis of the prostate, the urethra at the prostatic apex, and the left and right pedicles containing prostatic neurovascular bundles). The study included 23 participants with different levels of surgical experience. Completion times were recorded to assess surgical skills, and a subsequent questionnaire was filled out to verify the usability of our tools.

Results The average total completion time was 517.9±281.1 (mean±SD) seconds. The mean time of participants with no previous experience was 675.9±323.23 s, while that of medical undergraduates was 503±201.55 s. Professional subjects' (residents and surgeons) mean time was 329.7 (SD: ±75.72) s. When evaluating completion times for each task, the mean time of transecting the dorsal venous plexus was 71.1±50.26 s, while the time of transecting the right and left pedicles were 80.8±44.5 and 150.2±143.92 s, respectively. Transecting the urethra at the basis of the prostate and the prostatic apex took 131.6±87.87 and 84.2±45.69 s on average. In the subsequent questionnaire, all subjects evaluated the whole arrangement, the tasks, the trainer box and the pelvic phantom on a scale from 1 to 5. The arrangement received a mean rating of 4.85 points, the tasks received 4.412 points. The trainer box and pelvic phantom received 4.43 and 4.64 points, respectively.

Conclusion Our results show that subjects with relevant laparoscopic experience perform surgical tasks significantly faster than medical undergraduates and inexperienced participants. The favourable results of the questionnaire represent a good starting point for the further validation of our trainer box and pelvic phantom.

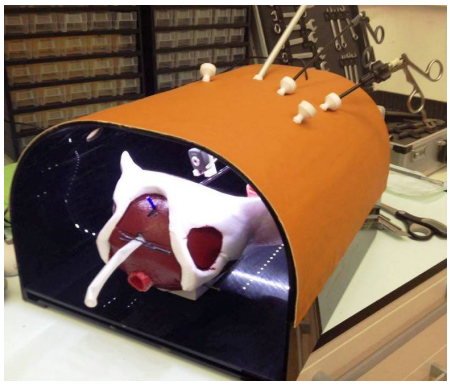

Fig. 1. Custom designed laparoscopic box trainer

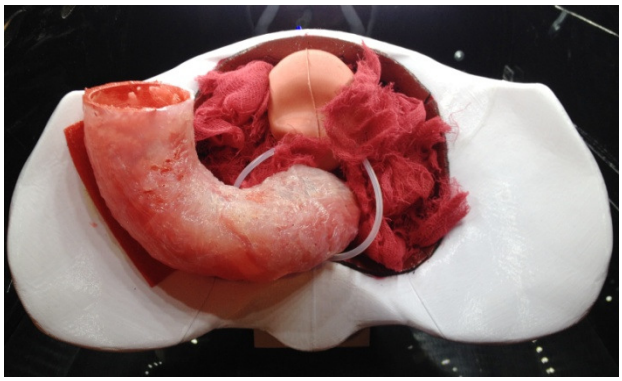

Fig. 2. Pelvic phantom with anatomical structures